



# **NSRL-0 RUN**

## **FINAL REPORT**

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**BNL/NASA webpage:**  
**<http://www.bnl.gov/medical/NASA/NASA-home%20frame.htm>**

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## EXECUTIVE SUMMARY

During the summer of 2003, a series of radiobiological and physics experiments were performed using the NASA Space Radiation Laboratory to accelerate iron, carbon and titanium beams (NSRL-0). These experiments were part of the NSRL commissioning run sponsored by NASA's Space Radiation Health Program (SRHP) heavy ion radiobiology research program at BNL.

A total of 12 proposals were approved to participate in the NSRL-0 run. Seven institutions from the United States and 2 from foreign countries (Italy and Japan) were represented, totaling 33 users. More than 900 biological samples were exposed at the NSRL beam line, employing 158 hours of beam time (33.5 hours for in vivo studies and 48 hours for in vitro studies). In addition, 36 hours were used for physics experiments, and a total of 24.5 hours were necessary for beam characterization, tuning, dosimetry, and calibration. A total of 16 hours of beam time were lost (10%) due to accelerator or power supply related problems.

During NSRL-0, AGS provided iron (0.964 GeV/nucleon, LET: 151.5 keV/ $\mu$ m), Carbon (0.292 GeV/n, LET: 12.9 keV/ $\mu$ m) and Titanium (0.976 GeV/n, LET: 108.2 keV/ $\mu$ m) beams for biology and physics experiments. The dose/rates used were as low as 1 cGy/min and as high as 2.5 Gy/min. The spill rate employed was 11 for Fe and Ti and 30 spills/min for C with duration of 400 msec/spill. The spill fluence was (particles/spill)  $4 \times 10^9$  (max) and  $5 \times 10^5$  (min). A 20 x 20 cm square beam spot was employed as a nominal spot for the majority of the exposures.

Tandem-Booster set-up started on July 5 with the transport and circulation of Fe beams at the NSRL complex. Beam was tuned into cave on July 7. 1000 MeV/n Fe beams were available for tuning on July 6. The next several shifts were spent on beam development (A. Rusek: tuning into the target area, beam diagnostics and establishing several different combinations of beam intensities and spot shapes and sizes for physics and biology studies) and some physics experiments (J. Miller: beam characterization). Biology studies started on the afternoon of July 8 (M. Vazquez, BNL)) and proceeded through early July 11. On July 14, AGS tuned 0.29 GeV/n carbon beams for physics studies for 13 hours. Biology studies started on July 15 (B. Sutherland, BNL) and continued until July 18. On July 21, AGS complex delivered titanium beams for beam development and physics. Biology experiments started on July 22 (F. Cucinotta, JSC) running until early afternoon on July 24. NSRL-0 officially ended at 1330 pm, July 24 2003.

Radiobiological experiments employed cells, tissues, and intact specimens, which required a complex coordination and planning of their respective logistic support. Biological studies used human, mouse, rat and hamster cell lines, human-hamster hybrid cell lines, tumor cell lines and intact specimens (rodents). The full program was completed in 17 days.

**Projects Approved by NASA and BNL's management for the NSRL  
Commissioning run (NSRL-0):**

<b>Project</b>	<b>P.I.</b>	<b>NSRL-0 Participation</b>
<b>N-9</b>	<b>Gewirtz/Sutherland</b>	<b>Yes</b>
<b>N-19</b>	<b>Kronenberg</b>	<b>Yes</b>
<b>N-73</b>	<b>Sutherland</b>	<b>Yes</b>
<b>N-76</b>	<b>Green</b>	<b>Yes</b>
<b>N-77</b>	<b>Nelson</b>	<b>Yes</b>
<b>N-78</b>	<b>Nelson</b>	<b>Yes</b>
<b>N-79</b>	<b>Pecaut</b>	<b>Yes</b>
<b>N-80</b>	<b>Gonda</b>	<b>Yes</b>
<b>N-81</b>	<b>Vazquez</b>	<b>Yes</b>
<b>N-82</b>	<b>Obenaus</b>	<b>Yes</b>
<b>N-83</b>	<b>Obenaus</b>	<b>Yes</b>
<b>N-84</b>	<b>Cucinotta</b>	<b>Yes</b>

## **NSRL-0 PARTICIPANTS**

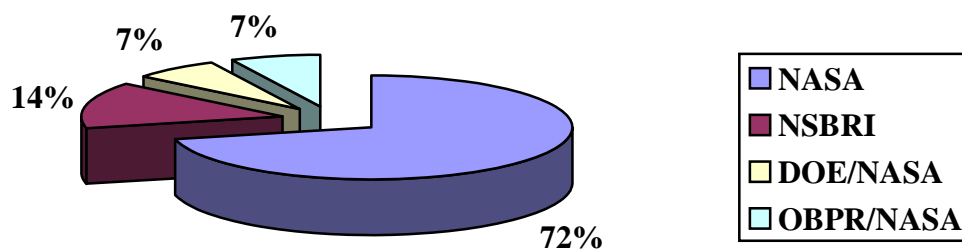
<b>Exp.</b>	<b>Participants</b>	<b>Affiliation</b>	<b>Title</b>
N-9	A. Gerwartz* B. Sutherland P. Bennett A. Georgakilas M. Hada S. Paul J. Sutherland D. Monteleone J. Trunk	University of Pennsylvania, Dept. of Medicine Brookhaven National Laboratory " " " " " " " "	Ph.D., Principal Investigator Ph.D., Co-Principal Invest. MS., Biology Associate Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Co-Worker Co-Worker
N-19	A. Kronenberg	Lawrence Berkeley National Lab	Ph.D., Principal Investigator
N-73	B. Sutherland P. Bennett A. Georgakilas M. Hada S. Paul J. Sutherland D. Monteleone J. Trunk	Brookhaven National Laboratory " " " " " " " "	Ph.D., Principal Investigator MS., Biology Associate Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Co-Worker Co-Worker
N-76	L. Green B. Bianski	Loma Linda University, CA "	Ph.D., Principal Investigator Co-Worker
N-77 N-78	G. Nelson A. Smith T. Jones	Loma Linda University, CA " "	Ph.D., Principal Investigator BS, Co-Worker BS, Co-Worker
N-79	M. Pecaut G. Nelson A. Smith S. Rightnar T. Jones	Loma Linda University, CA " " " "	Ph.D., Principal Investigator Ph.D., Co-Principal Invest. BS, Co-Worker BS, Co-Worker BS, Co-Worker
N-80	S. Gonda E. Behravesh	NASA, Johnson Space Center, TX "	Ph.D., Principal Investigator Ph.D., Co-Worker
N-81	M. Vazquez P. Guida K. Nojima S. Otto M. Bruneus A. Billups S. Russell	Brookhaven National Laboratory " " " " " " "	MD, Ph.D., Principal Invest. Ph.D., Co-Worker Ph.D., Co-Worker BS, Co-Worker MA, Co-Worker BA, Co-Worker BS, Co-Worker
N-82 N-83	A. Obenaus	Loma Linda University, CA	Ph.D., Principal Investigator
N-84	F. Cucinotta K. George P. O'Neill E. Davis H. Wu N. Desai M. Durante	NASA, Johnson Space Center, TX " " " " " University "Federico II", Napoli, Italy	Ph.D., Principal Investigator Senior Research Associate Ph.D., Co-Principal Invest. Ph.D., Co-Worker Ph.D., Co-Worker BS, Co-Worker Ph.D., Co-Worker

**\*Not Present During Actual Run**

## NSRL-0 PARTICIPANTS STATISTICS

<b>PARTICIPANTS</b>	<b>NSRL-0</b>
<b>Ph.D., Principal Investigators</b>	<b>10</b>
<b>M.D., Ph.D., Principal Investigators</b>	<b>1</b>
<b>Ph.D., Co-Principal Investigators</b>	<b>3</b>
<b>Ph.D., Co-Investigator</b>	<b>0</b>
<b>Co-Workers</b>	<b>4</b>
<b>Ph.D.</b>	<b>14</b>
<b>M.D.</b>	<b>1</b>
<b>B.S./B.A.</b>	<b>9</b>
<b>M.S./M.A.</b>	<b>3</b>
<b>MS Biology Associate</b>	<b>1</b>
<b>Senior Research Associates</b>	<b>1</b>
<b>Undergraduate Student</b>	<b>0</b>
<b>Total:</b>	<b>33</b>

## RESEARCH PROJECT SPONSORS:



## **PARTICIPANT INSTITUTIONS**

### **NASA related centers/institutes (3)**

- NASA, Headquarters, DC
- NASA, Johnson Space Center, TX
- National Space Biomedical Research Institute, TX

### **National Laboratories/Institutes (2)**

- Brookhaven National Laboratory, NY
- Lawrence Berkeley National Laboratory, CA

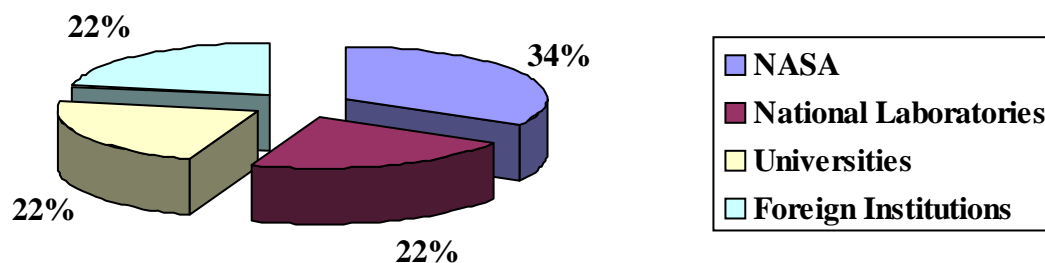
### **Universities (2)**

- Loma Linda University, CA
- University of Pennsylvania, PA

### **Foreign Institutions (2)**

- University “Federico II”, Napoli, Italy
- International Space Radiation Laboratory, Chiba, Japan

## **INSTITUTIONS STATISTICS:**



## NSRL-0 IRON RUN DESCRIPTION

### RUN DATES

Run dates	Scheduled		Actual	
	Date	Time	Date	Time
Run start	07/07	0700	07/07	0700
Run end	07/11	1900	07/11	2000
Tuned into cave	07/07	0700	07/07	1200
Beam delivered for Physics				
Fe 1 GeV/n	07/07	0900	07/07	1400
End run	07/08	1300	07/08	1230
Beam delivered for Biology				
Fe 1 GeV/n	07/08	1300	07/08	1500
End run	07/11	1900	07/11	2000

### BEAM TIME DESCRIPTION (hours)

Total Clock Time	(from 07/07 0700 to 07/11 2000)		62.5
Total Beam-on time			56.5
Total Beam-off time			6
Beam Time for Biology			
Fe 1 GeV/n In Vitro Studies	20		
Fe 1 GeV/n In Vivo Studies	12.5		
Sub-total		32.5	
Beam Time for Physics			
Fe 1 GeV/n	10		
Sub-total		10	
Beam time for dosimetry, calibration, tuning, etc.			
Fe 1 GeV/n	4		
Sub-total		4	
Set Up Time			
Fe 1 GeV/n	10		
Sub-total		10	
Totals		56.5	
Contingency T. Planned	12.5		
Contingency T. Used	8		

## **NSRL-0 CARBON RUN DESCRIPTION**

### **RUN DATES**

Run dates	Scheduled		Actual	
	Date	Time	Date	Time
Run start	07/14	0700	07/14	0700
Run end	07/18	1800	07/18	1330
Tuned into cave	07/14	0700	07/14	0815
Beam delivered for Physics				
C 0.29 GeV/n	07/14	0900	07/14	1200
End run	07/15	1300	07/15	1400
Beam delivered for Biology				
C 0.29 GeV/n	07/15	1300	07/15	1400
End run	07/18	1800	07/18	1330

### **BEAM TIME DESCRIPTION (hours)**

Total Clock Time	(from 07/14 0700 to 07/18 1330)		52.5
Total Beam-on time			50
Total Beam-off time			2.5
Beam Time for Biology			
In Vitro Studies	13		
In Vivo Studies	11		
Sub-total		24	
Beam Time for Physics			
C 0.29 GeV/n	13		
Sub-total		13	
Beam time for dosimetry, calibration, tuning, etc.			
C 0.29 GeV/n	0		
Sub-total		0	
Set Up Time			
C 0.29 GeV/n	13		
Sub-total		13	
Contingency T. Planned	8		
Contingency T. Used	6		
Totals		56.5	

## NSRL-0 TITANIUM RUN DESCRIPTION

### **RUN DATES**

Run dates	Scheduled		Actual	
	Date	Time	Date	Time
Run start	07/21	0700	07/21	0700
Run end	07/24	1800	07/24	1330
Tuned into cave	07/21	0700	07/21	0815
Beam delivered for Physics				
Ti 1 GeV/n	07/21	0900	07/21	0900
End run	07/22	1300	07/22	1100
Beam delivered for Biology				
Ti 1 GeV/n	07/22	0900	07/22	1600
End run	07/24	1800	07/24	1330

### **BEAM TIME DESCRIPTION (hours)**

Total Clock Time	(from 07/21 0700 to 07/24 1330)		43
Total Beam-on time			35.5
Total Beam-off time			7.5
Beam Time for Biology			
In Vitro Studies	15		
In Vivo Studies	0		
Sub-total		15	
Beam Time for Physics			
Ti 1 GeV/n	13		
Sub-total		13	
Beam time for dosimetry, calibration, tuning, etc.			
Ti 1 GeV/n	0		
Sub-total		0	
Set Up Time			
Ti 1 GeV/n	7.5		
Sub-total		7.5	
Contingency T. Planned	6.5		
Contingency T. Used	4.5		
Totals		35.5	

## NSRL-0 FINAL RUN DATES

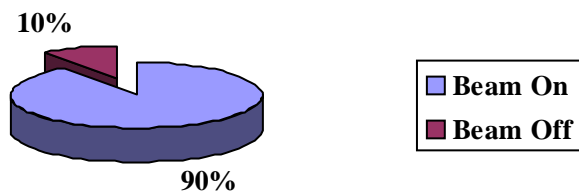
Run dates	Scheduled		Actual	
	Date	Time	Date	Time
Run start	07/07	0700	07/07	0700
Run end	07/24	1800	07/24	1330
Tuned into cave	07/07	0700	07/07	1200

## TOTAL BEAM TIME DESCRIPTION (hours)

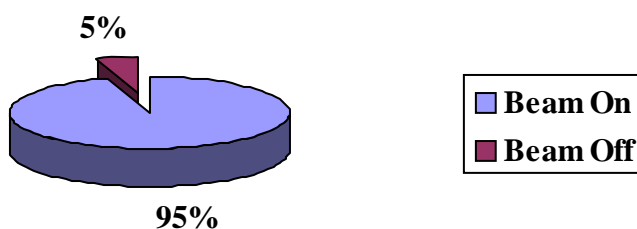
Total Clock Time	(from 07/07 0700 to 07/24 1330)		158
Total Beam-on Time			
Fe 1 GeV/n	56.5		
C 0.29 GeV/n	50.0		
Ti 1 GeV/n	35.5		
Total		142	
Total Beam-off time			
Fe 1 GeV/n	6		
C 0.29 GeV/n	2.5		
Ti 1 GeV/n	7.5		
Total		16	
Total Beam Time for Biology			
In Vivo Studies	33.5		
In Vitro Studies	48		
Total		81.5	
Beam Time for Physics	36		
Total		36	
Beam time for dosimetry, calibration, tuning, etc.	4		
Total		4	
Set Up Time	20.5		
Total		20.5	
Contingency T. Planned	27		
Contingency T. Used	8.5		
Totals		142	158

## DESCRIPTIVE STATISTICS

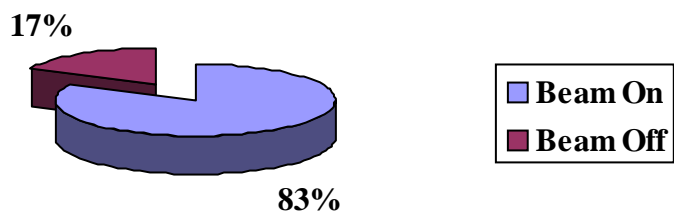
- **FE 1 GEV/N BEAM AVAILABILITY**



- **C 290 MEV/N BEAM AVAILABILITY**

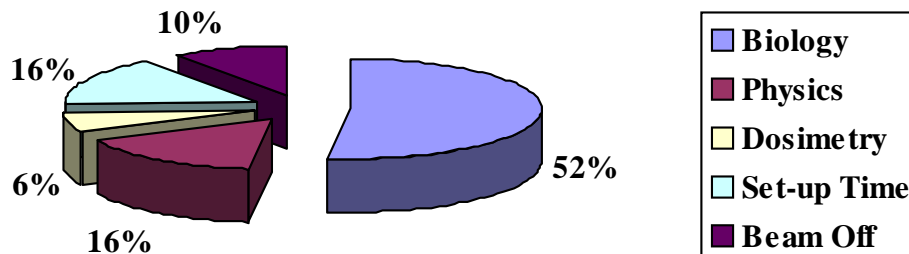


- **TI 1 GEV/N BEAM AVAILABILITY**

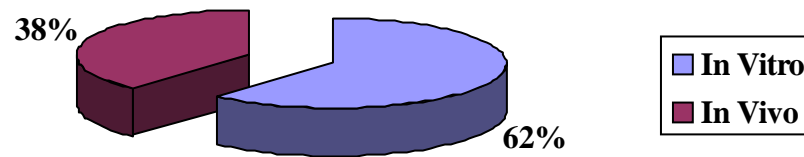


### **IRON ION RUN:**

- **FE 1 GEV/N DISTRIBUTION OF BEAM TIME USAGE:**

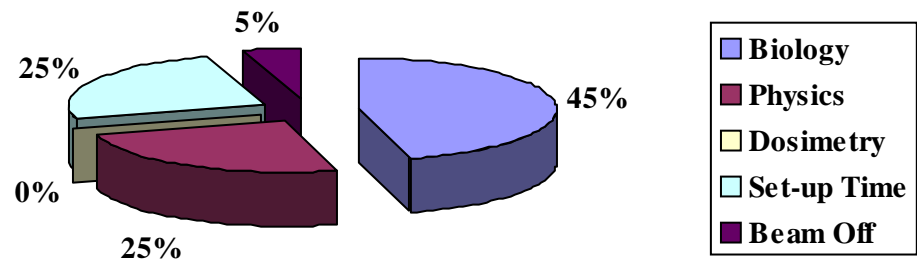


- **FE 1 GEV/N DISTRIBUTION OF BEAM TIME FOR BIOLOGY:**

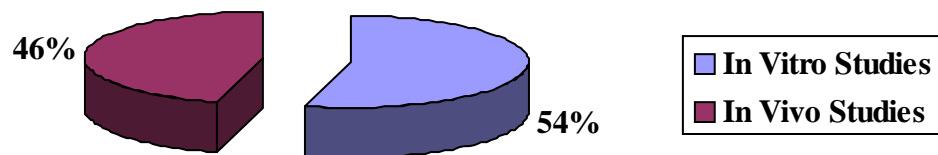


## **CARBON ION RUN**

- **C 0.29 GEV/N DISTRIBUTION OF BEAM TIME USAGE:**

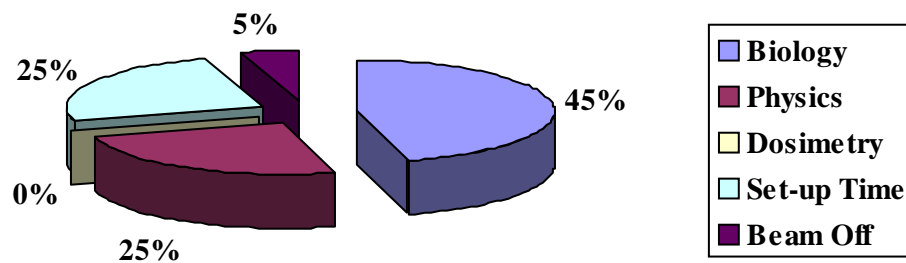


- **C 0.29 GEV/N DISTRIBUTION OF BEAM TIME FOR BIOLOGY:**

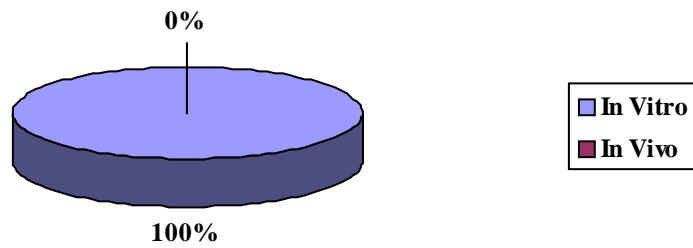


## **TITANIUM ION RUN**

- **SI 1 GEV/N DISTRIBUTION OF BEAM TIME USAGE:**

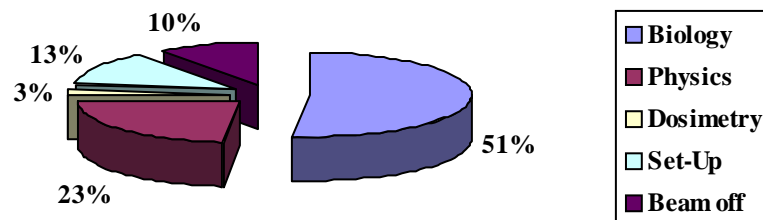


- **TI 1 GEV/N DISTRIBUTION OF BEAM TIME FOR BIOLOGY:**

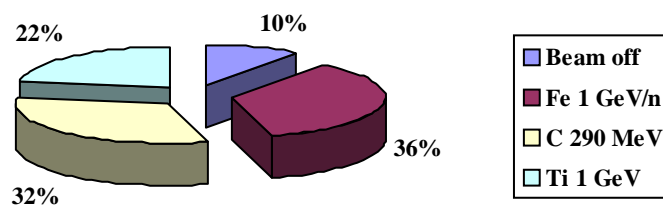


## **NSRL-0 TOTAL BEAM TIME SUMMARY**

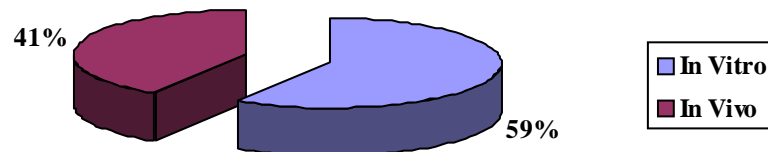
- **DISTRIBUTION OF BEAM TEAM USAGE:**



- **DISTRIBUTION OF BEAM TEAM BY SPECIES AND ENERGIES:**



- **DISTRIBUTION OF BEAM TEAM FOR BIOLOGY EXPERIMENTS:**



## **BEAM CHARACTERISTICS**

<b>Ion</b>	<b><sup>56</sup>Fe<sup>26</sup></b>	<b><sup>48</sup>Ti<sup>22</sup></b>	<b><sup>12</sup>C<sup>6</sup></b>
<b>Fluence (particles/cm<sup>2</sup>/sec)</b>			
<b>Maximum on target</b>	<b>TBD</b>	<b>TBD</b>	<b>TBD</b>
<b>Minimum on target</b>			
<b>Spill rate (spills/min)</b>	<b>11</b>	<b>11</b>	<b>30</b>
<b>Spill length (msec)</b>	<b>400</b>	<b>400</b>	<b>400</b>
<b>Particles/spill</b>			
<b>Maximum</b>	<b>1 x 10<sup>9</sup></b>	<b>3.5 x 10<sup>8</sup></b>	<b>4.0 x 10<sup>9</sup></b>
<b>Minimum</b>	<b>5.0 x 10<sup>2</sup></b>	<b>5.0 x 10<sup>2</sup></b>	<b>5.0 x 10<sup>2</sup></b>
<b>Beam Size</b>	<b>25 x 25</b>	<b>20 x 20, 10 x 10</b>	<b>25 x 25</b>
<b>Beam Cut Off Accuracy</b>	<b>~ 0.5 %</b>	<b>~ 0.5 %</b>	<b>~ 0.5 %</b>
<b>Actual Energy (MeV/n)</b>			
<b>Extracted</b>	<b>1005</b>	<b>1007</b>	<b>300</b>
<b>On Target</b>	<b>964</b>	<b>976</b>	<b>292</b>
<b>Actual LET on Target (keV/μm)</b>	<b>151.5</b>	<b>108.2</b>	<b>12.9</b>
<b>Dose Rate (Gy/min)</b>			
<b>Maximum</b>	<b>3.0</b>	<b>.5 (20 x 20), 2.5 (10 x 10)</b>	<b>3.0</b>
<b>Minimum</b>	<b>0.01</b>	<b>0.01</b>	<b>0.01</b>
<b>Total Dose (Gy)</b>			
<b>Maximum</b>	<b>5</b>	<b>5</b>	<b>5</b>
<b>Minimum</b>	<b>0.1</b>	<b>0.1</b>	<b>0.1</b>

The “On Target” energies were obtained from Bragg Curve measurements.

The LET reported here is that for the primary ion at the “on target” energy. Fragmentation was not taken into account. If significant, fragmentation would result in a lower LET (fragmentation does not appear to be significant at the target area).

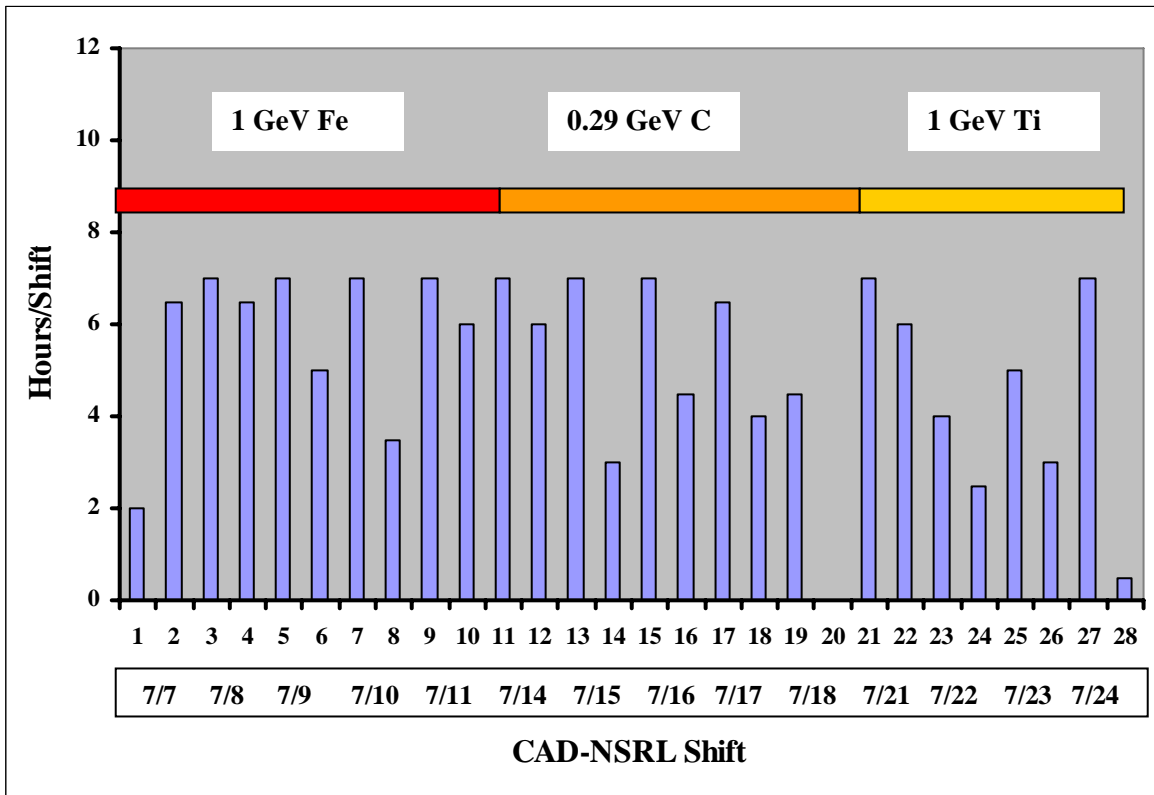
The Dose Rate is measured at the center of the ion-chamber, and does not necessarily scale with beam size.

## NSRL-0 Run Statistics and Incidents

Date	Shift	HIP Avail. (set-up t.)	Non-HIP*	Remarks (CAD 2 shift/day: 7-14/14-21 hr)
07/07/02	1	2 (2)	5	1 GeV/n Fe run start. Booster magnet trip.
	2	6.5	0	No incidents.
07/08/02	3	7 (2)	0	No incidents. End Physics Beam development run
	4	6.5	0	No incidents. Biology run start.
07/09/02	5	7 (2)	0	No incidents.
	6	5	1	Gate door security problems
07/10/02	7	7 (2)	0	No incidents.
	8	3.5	0	No incidents.
07/11/02	9	7 (2)	0	Tandem problems (valves closed), Vacuum leak at
	10	6	0	Booster. Vacuum leak at TTB
07/14/02	11	7 (5)	0	Switch to C 0.29 GeV/n.
	12	6	0	Physics run Beam development
07/15/02	13	7 (2)	0	Physics run completed
	14	3	0	Biology run start
07/16/02	15	7 (16)	0	No incidents.
	16	4.5	0	No incidents.
07/17/02	17	6.5 (2)	0.5	Sweep lost.
	18	4	0	No incidents.
07/18/02	19	4.5 (2)	2	False fire alarm
	20			CAD beam development (Adam Rusek)
07/21/02	21	7 (2)	0	Switch to Ti 1 GeV/n. Physics run start.
	22	6	0	No incidents.
07/22/02	23	4 (2)	3	Physics run end. Magnet cooling system problems.
	24	2.5	2	Magnet problems. Biology run start.
07/23/02	25	5 (1.5)	2	RHIC fire alarm. Transport problems.
	26	3	0.5	Sweep lost.
07/24/02	27	7 (2)	0	No incidents.
	28	0.5	0	End NSRL-0
<b>Totals:</b>	<b>18</b>	<b>142 hr. (89%)</b>	<b>16 hr. (11%)</b>	

\*Time loss due to machine or power supply problems, setting up operations.

## NSRL-0 BEAM TIME AVAILABILITY SUMMARY



### NSRL-0 operational schedule assumptions:

- 7 to 9 am: set-up, initial dosimetry (2 hr)
- 9 to 17 pm: experimental run (8 hr)
- 17 to 19 pm: contingency and wrap up operations (2 hr)

Total daily operation: 12 hrs

## NSRL-0 EXPERIMENTERS AND RUN STATISTICS

Exp. ID	Principal Investigator	Ion & Energy	Beam T. Approv.	Beam Time Used	Dose Range (cGy)	Dose/Rate (cGy/min)	Number of Samples
N-9	Gewirtz	Fe, 1 GeV/n C, 290 MeV/n Ti, 1 GeV/n	0.5 0.5 0.5	0.5 0.5 0.5	10-30	100	50
N-19	Kronenberg	Fe, 1 GeV/n C, 290 MeV/n Ti, 1 GeV/n	3 0 3	5.5 3.0 2.5	15.75-189 14-168 12.3-147.6	40-80 50-100 30-50	21 21 21
N-73	Sutherland	Fe, 1 GeV/n C, 290 MeV/n Ti, 1 GeV/n	3 3 3	2.0 2.5 4.0	10 to 25000	50 to 2000	200
N-76	Green	Fe, 1 GeV/n	1.5	2.5	0-50	50	13
N-77	Nelson	Fe, 1 GeV/n C, 290 MeV/n Ti, 1 GeV/n	4.2 4.8 3.4	3.5 3.0 1.0	100 to 1000	1000	100
N-78	Nelson	C, 290 MeV/n	2.5	3.0	100 to 1000	200	50
N-79	Pecaut	Fe, 1 GeV/n C, 290 MeV/n	0 2.75	0.0 3.0	0-200 0-500	70-90 120-210	9 54
N-80	Gonda	Fe, 1 GeV/n C, 290 MeV/n	2 2	1.5 2.0	10-200 20-400	100 200	30 30
N-81	Vazquez	Fe, 1 GeV/n C, 290 MeV/n Ti, 1 GeV/n	7 2 2	9.0 1.5 2.0	0-240 0-200 0-200	40-50 40-50 40-50	140 50 60
N-82	Obenaus	Fe, 1 GeV/n C, 290 MeV/n Ti, 1 GeV/n	1.3 1.3 2.3	1.0 2.0 1.0	10 to 200 10 to 200 10 to 200	200	8 8 8
N-83	Obenaus	Fe, 1 GeV/n C, 290 MeV/n	5.5 5.5	4 1.0	10 to 200 10 to 200	200	30 30
N-84	Cucinotta	Fe, 1 GeV/n C, 290 MeV/n Ti, 1 GeV/n	4 1.5 2.5	3.0 3.5 2.5	2-300	100	50
<b>Totals</b>			<b>73.7</b>	<b>71</b>	<b>0-25000</b>	<b>30-2000</b>	<b>983</b>

## NSRL-0 PARTICIPANTS, EXPERIMENTAL SAMPLES AND ENDPOINTS

Exp.	Participants	Samples	Endpoints
N-9	Effects of Deep Space Radiation on Human Hematopoietic Stem Cells <b>A. Gewirtz (PI)</b>	Human bone marrow mononuclear cells	Production of differentiated, lineage-specific cells in CFU assays. Alterations in gene expression patterns by microarray analysis.
N-19	Mutagenesis and Genomic Instability in Human cells <b>A. Kronenberg (PI)</b>	Human lymphoid cells (TK6)	Cell killing comparisons to previously published results, colony formation and survival curves.
N-73	DNA damage clusters in low level radiation responses of human cells. <b>B. Sutherland (PI)</b>	T7 DNA Human bone marrow cells Human monocytes Supercoiled DNA	DNA damage cluster induction and repair at the molecular and cellular levels.
N-76	Response of Thyroid Tissue Units to Space-Like Radiation Fields. <b>L. Green (PI)</b>	FRTL-5 cells (rat thyroid)	Gene expression alterations.
N-78	Carbon Radiation Induced Gene Expression in C57BL/6 Mice. <b>G. Nelson (PI)</b>	C57BL/6 Mice	Gene expression using microarray analysis.
N-79	The Effects of Head-Only and Whole-Body Irradiation on CNS-Immune Function. <b>M. Pecaut (PI)</b>	C45BL/6 Mice	Interleukin-1 expression using immunohistochemical (IHC) and MRI analysis.
N-80	Comparison of Cell and Tissue 3D Models for Assessment of Genotoxic Damage by High Energy Charged Particles. <b>S. Gonda (PI)</b>	Normal & Transgenic fibroblast cells Normal & Transgenic epithelial cells	Mutation types and frequency induced in target genes at molecular level Dose relationships
N-81	In Vitro and In Vivo CNS Damage Studies <b>M. Vazquez (PI)</b>	C57BL/6 Mice NT-2 neural stem cells hNT post-mitotic neurons	Behavioral Testing: Locomotor activity Survival, apoptosis, gene expression
N-82	Dosimetry Gels (Magic Gels) as Biological Reporters of Radiation Dose. <b>A. Obenaus (PI)</b>	Dosimetry Gels (Magic Gels)	A more complete dose response curve.
N-83	Changes in Neuronal Excitability Following $^{56}\text{Fe}$ and Carbon Irradiation: Correlation of Electrophysiological Alterations with Magnetic Resonance Imaging. <b>A. Obenaus (PI)</b>	Sprague-Dawley Rats	Neuroimaging using MRI and MRS.
N-84	Comparison of Cytogenetic Damage measured at the NASA Space Radiation Laboratory (NSRL) to Results from AGS and HIMAC. <b>F. Cucinotta (PI)</b>	Normal human lymphocytes and fibroblasts	Cytogenetic damage DNA double strand breaks and repair by immuno staining.

## List of personnel that participated in the planning, organization and execution of NSRL-0 run

### BNL Management:

- Laboratory Director: **Peter Paul**
- Associate Director for High Energy and Nuclear Physics: **Tom Kirk**
- Associate Laboratory Director for Life Sciences: **Helene Benveniste**

### NASA Management:

- Headquarters: **Walter Schimmerling, David Tomko**
- JSC: **Frank Cucinotta, Frank Sulzman, Barbara Corbin**

### Scientific Advisory Committee:

- **Betsy Sutherland** (Chair), BNL
- **Louis Pena**, BNL
- **Richard Setlow**, BNL
- **Joel Bedford**, CSU
- **Les Braby**, PNL
- **Charles Geard**, Columbia University

### Collider Accelerator Department-AGS

- Chairman: **Derek Lowenstein**
- Deputy Chairman: **W.T. Weng**
- Associate Chair of Operations: **A.J. McNerney**
- Experimental Planning and Support Head: **Philip Pile**
- Associate Chair for ESHQ: **Ed Lessard**
- ESHQ Division Head: **Ray Karol**
- ESH Coordinator: **Asher Etkin**
- Facility Support Representative: **Chuck Schaefer / Henry Kahnhauser**
- Environmental Coordinator: **Joel Scott**
- Training and Procedures Manager : **John Maraviglia**
- Main Control Room: **Peter Ingrassia**
- Work Control Manager: **Peter Cirnigliaro**
- BNL Laser Safety Officer: **Chris Weilandics**
- Experimental Safety Review Committee: **Yousef Makdisi (Chair)**
- Radiation Safety Committee: **Dana Beavis (Chair)**
- Accelerator Safety Review Committee: **Woody Glenn (Chair)**
- ALARA Committee: **Chuck Schaefer (Chair)**
- Associate Chair for ES&H/Q.A: **E. Lessard**
- Accelerator Division Head: **Thomas Roser**
- Chief Electrical Engineer: **J. Sandberg**

- Chief Mechanical Engineer: **J. Tuozzolo**
- Accelerator Physicist lead by: **Leif Aherns**
- Tandem Group leader: **Peter Thieberger**
- Physics Support: **Yusef Makadisi**
- CAD Components and instrumentation support: **David Gassner**
- AGS Radiation Safety Committee: **Ken Reece**
- C-A Dept Training Manager: **John Maraviglia**
- AGS Control Section lead by: **Don Barton**
- Liaison Engineering Group lead by: **David Phillips**
- Liaison physicist: **Adam Rusek**
- RHIC&AGS Users Center: **Susan White-DePace, Angela Melocoton**
- Mechanical Service Technicians led by: **Fred Kobasiuk**
- Survey Group led by: **Frank Karl**
- Beam Service Technicians led by: **Paul Valli**
- Electronic Service Technicians led by: **Bill Anderson**
- AGS Instrumentation Group led by: **Pete Stillman**
- AGS Main Control Room and Operations led by: **Pete Ingrassia**
- **AGS MCR Operation Coordinators:**
  - Jim Jamilkowski**
  - Greg Marr**
  - Sanjee Abeytunge**
  - Jennifer Kozak**
  - Brian van Kuik,**
  - Travis Shrey**
- AGS Electricians led by **Bill Softye**
- AGS Riggers led by: **Nick Cipolla**
- Carpenter and Welder Support Service and Technical Support led by: **Roger Hubbard**

#### **Dosimetry:**

- **Don Lazarus**
- **Adam Rusek**
- **I-Hung Chiang**
- **Kin Yip**
- **Peter Oddo**
- **Bart Frak**

### **Medical Department:**

#### **NASA LTSF TEAM:**

- **Medical Liaisons: Marcelo E. Vazquez, Peter Guida**
- **Technical support: Bea Pyatt, Stacey Russell, Adele Billups**
  - Dept. Chair: **John Gatley**
  - Building Manager: **Chris Harris**
  - Administration: **Denise White and Donna Russo**
  - Animal Care Facilities: **Maryann Kershaw, Kerry Bonti, Patricia Leone**
  - Training Coordinator: **Ann Emrick**
  - **RCD**
    - Kay Conkling
    - Dennis Ryan
    - Deana Buckallew
    - Jim Williams
    - Bob Colichio

### **Plant Engineering:**

- BLAF Custodian, **P. Abrams**
- Plumbers: **B. McCafferty**
- Painters/Carpenters: **B. Laakmann**
- Electricians: **T. Baldwin**

### **Biology Department:**

- Chairman: **Carl Anderson**
- Biology Liason: **Betsy Sutherland**
- Technical Support: **Mamta Naidu, Debasish Roy**
- Cesium Source Manager: **Richard Sautkulis**

### **Lawrence Berkeley National Laboratory Dosimetry Technical Support:**

- **R. P. Singh**

## NSRL-0 PICTORIAL



**NSRL-0 participants: First row left to right, Marco Durante (ISA), Tamako Jones (LLUMC), Kerry George (JSC), Kumie Nojima (NIRS); second row, Amy Kronenberg (LBNL), Marcelo Vazquez (BNL), Betsy Sutherland (BNL), Anna Smith (LLUMC); third row, Adam Rusek (BNL), Frank Cuccinota (JSC), John Sutherland (BNL), Andrew Obenaus (LLUMC), Greg Nelson (LLUMC); last row, Jack Miller (LBNL), S. Guetersloh and Michael Pecaut.**